VISION EASE®

Blue Filter Lens Technologies

Introducing Clear Blue Filter Lenses providing high-energy light protection in a clear, everyday polycarbonate lens!

1 credit hour ABO APPROVED CE

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Our aim as eye care professionals is to be knowledgeable about all lens technologies that benefit our customers. In this course we will introduce Clear Blue Filter Lenses by VISION EASE and explain how this new clear lens technology helps our customers by blocking ultra violet radiation up to 400nm and by filtering short wavelength blue light. We will also cover the other two types of blue filter lens technologies currently available in the market. This course will provide background information on the effects of short wavelength blue light as well as ultraviolet radiation on eyehealth and visual acuity. And, we will review the effect of long blue wavelengths of light on our circadian rhythm.

Blue News is Alarming Consumers

The internet is full of alarming messages about blue light and its ability to harm the eye and interfere with our sleep/wake cycle. Much of the information that consumers are being bombarded with is confusing. As their trusted Eye Care Professional it is our responsibility to educate them. There are simple things consumers can do to avoid exposure to the high energy light that harms the eye. And, there are simple things they can do to avoid blue light that interferes with sleep.

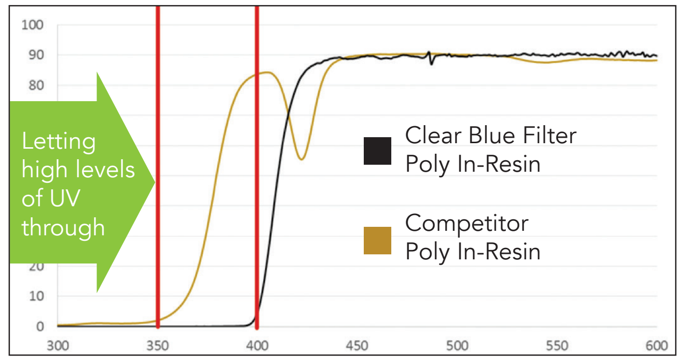
Three Blue Filter Lens Technologies

Until recently we had two ways to reduce the transmission of blue light through a lens: Blue deflector (reflective) coatings and Pigmented (tinted) lenses. And now we have clear solutions with UV and blue light absorbers built into the lens (in-resin).

Let's review the three blue filter lens technologies:

1. In-resin: New clear blue filter lens technology utilizes optimized monomers that have UV and short wavelength blue light filters built into the lens. These new clear in-resin products selectively absorb violet/blue visible wavelengths between 400 to 460nm.

Depending on the manufacturer their transmission curves of both UV and short wavelength blue light will differ. Clear in-resin products come in polycarbonate, 1.60, 1.67 and 1.74. There are currently two manufacturers of clear polycarbonate in-resin products. Of these only Clear Blue Filter Lenses provide 100% UV400 protection. The other as illustrated in the graph below allows a window between 380nm and 400nm to transmit through the lens and is currently only available in their premium digital lens offerings.



UV wavelengths are shorter than blue wavelengths and therefore should be of higher concern.

96%

of consumers rate CLARITY
as highly important in their lens choice

Clear Blue Filter Lenses are made from an optimized polycarbonate material and block 100% of UV up to 400nm plus 67% of short wavelength blue light between 400 and 425nm. The shortest wavelengths of blue light have the highest energy and initiate a viscous cycle of damage in the retina. It is important to prioritize the filtering of the shortest wavelengths in blue filter lenses.

Clear Blue Filter Lenses are the only clear polycarbonate blue filter lenses that block 100% of ultraviolet radiation up to 400nm. As a result, Clear Blue Filter is the only clear lens to receive the Skin Cancer Foundation seal of recommendation.

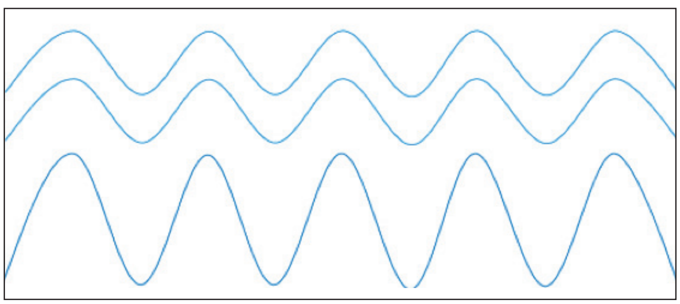
RECOMMENDED SKIN CANCER FOUNDATION

Recommended as an effective UV filter for the eyes and surrounding skin.

2. Amplified reflection/Blue deflector coating technology: A violet or blue reflective coating utilizes constructive interference to deflect/reflect roughly twice the amount of the violet and blue wavelengths that would normally reflect from a lens surface. The higher the index of material the more light, and therefore more blue light is reflected from the lens surface.

Constructive interference amplifies reflection and specific wavelength's of violet/blue can be targeted. Conditions where waves have equal height (amplitude) and are in-phase (overlap) amplify their reflection from the lens surface.

The opposite principle is used to create anti-reflective (AR) coatings. AR coatings use the principle of destructive interference to eliminate reflections of specific wavelengths.



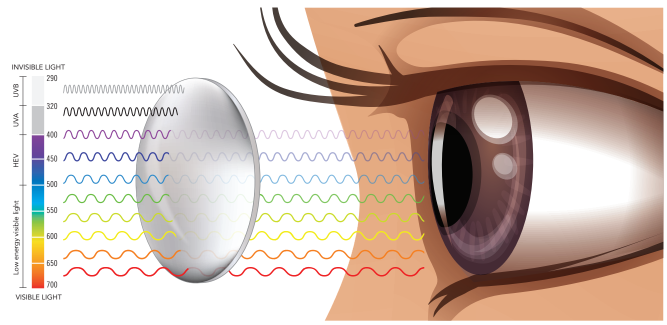
2 waves of equal amplitude and in-phase result in a reflected wave with 2x the amplitude.

3. Pigmented blue filter lens technology:
A yellowish brown or yellowish green tint/pigment in a lens absorbs wavelengths of their opposite or complimentary colors, violet and/or blue. The darker the pigment/tint, the greater the amount of violet and blue wavelengths absorbed preventing their transmission through the lens. In sunglasses with a dark tint, blue filter lenses are cosmetically attractive. In a lens clear enough to be used indoors, the same cannot be said. Remember the stat mentioned earlier; 96% rate clarity as highly important in their lens choice.

Complimentary colors absorb their opposite on the color wheel. Orange absorbs blue and yellow absorbs violet.

Now that we know the lens technologies available to reduce blue light exposure, let's look at the effects of blue light on acuity and its contribution to glare and eyestrain.

Short wavelength blue light is known to have deleterious effects on acuity and can contribute to glare. Glare reduces acuity and may contribute to eyestrain.



Short wavelength blue light molecules are attracted to the small molecules of hydrogen and oxygen present in our environment causing blue light to scatter in the air. The shorter the wavelength the greater it scatters causing what's known as veil illuminance or blue haze. In our industry we simply call it blue blur. The result of this scatter and blur is a

loss of contrast sensitivity where it becomes difficult for our eyes to see objects against their background as detail and edges become ill defined. Think of looking through a veil of haze. Blue light scatters up to ten times more than red light.[8]

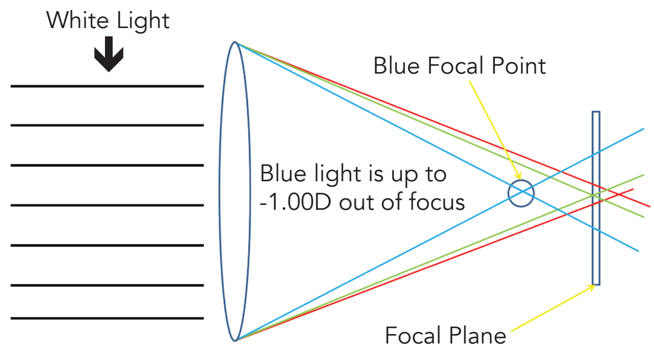
Blue light is scattered more than red light by a factor of $(700/400)^{4\sim}=10$.

We use our rod photoreceptors at night. They are highly sensitive to blue wavelengths. This makes blue light seem more glaring at night.

The eye is far more sensitive to blue light in the dark, making blue light look brighter at low light levels
(Courtesy of Teresa Goodman, National Physical Laboratory, UK)

Peak light sensitivity blue green

Blue light is never in focus. Due to its short wavelength it refracts more when it travels from air into a medium of a different index such our refractive structures the cornea and crystalline lens. Inside our eye blue light refracts (bends) more and therefore converges to a focal point sooner than green or red wavelengths of light. In fact they converge to a point too soon, before reaching the retina and we all know the condition where light focuses before reaching the retina is called myopia, in this case blue myopia.



Circadian Rhythm Link to Blue Light

How does blue light disrupt our circadian rhythm and cause sleep deprivation leading to increased levels of diabetes, cancer, obesity and behavior disorders and mental fog?

There are studies that indicate that exposure to too much blue light in the 460 to 480nm range within one to three (1-3) hours of bedtime can disrupt our normal circadian rhythm.[4] These wavelengths stimulate the production of Serotonin, the hormone that allows us to awaken in the morning and keeps us alert and happy throughout the day. As the sun goes down these wavelengths need to diminish, signaling our circadian clock it is time to suppress the 'wake' hormone serotonin and increase levels of the 'sleep' hormone melatonin. Exposing our eyes to high illumination levels too close to bedtime can keep serotonin levels high causing sleep disruption.

Blue light exposure from 460 to 480nm, too close to bedtime, is reportedly linked to circadian rhythm disruption and sleep deprivation.

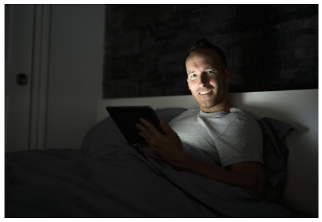
"Blue light, especially at night, can cause more eyestrain and eye fatigue than other types of light and may cause halo's around objects, because blue light makes it harder to focus. Just as blue light scatters in our atmosphere it scatters in our eyes as well, impairing vision."

– International Dark Sky Rev 2009/June

Wake Up Serotonin

460 to 480nm

Sleep Melatonin



Exposure too close to bedtime keep serotonin levels high and prevents melatonin increase to promote sleep

Sleep deprivation is implicated in many physiological and psychological health issues including increased rates of diabetes, cancer, behavior disorders and obesity. Our circadian rhythm determines our sleep and wake patterns based on the amount of illumination and is particularly sensitive to blue wavelengths from 460 to 480nm.

Products clear enough to use indoors will only lower the transmission of wavelengths in the 460 to 480nm range by 10% to 20%, from digital screens. There is currently no empirical evidence to support that such a small reduction will suppress serotonin and allow the increase of melatonin. And this is good because we use our everyday pair of lenses during the day when we need to be awake, alert and happy.

Fortunately screen emissions that impact circadian rhythm can be reduced by enabling display and brightness screen settings such as 'Night Shift' on Apple products. These settings allow you to automate your screen display brightness settings so that blue light transmissions are dimmed in the evening. The other option is avoidance of digital device screens close to bedtime. Note: It is important we not block these wavelengths inside during daytime hours as we need them to wake and stay awake.

What are the eye health risks posed by blue light and UV?

There is science based evidence that exposure to short wavelength blue light is a modifiable risk factor in the development of Age Related Macular Degeneration (AMD).

CIRCADIAN RHYTHM

The Melanopsin in our Intrinsically photosensitive retinal ganglion cells (Iprgc), a non-seeing type of photoreceptor cell, is most sensitive to the blue wavelengths of light. When these cells are exposed to 460 to 480nm wavelengths, of blue light, the production of serotonin (wake hormone) is stimulated by our Circadian Clock.

Understanding the importance of protecting the eye from harmful wavelengths prepares you to advise patients on the need for protection and how exposure to these wavelengths of light can be reduced.

Why is blue light considered a hazard to the retina and how is it linked to age related macular degeneration?

Excess exposure to both ultraviolet radiation and violet/blue wavelengths, have been shown to result in photochemical damage to retinal cells in a series of cellular and animal studies.[2,4] This photochemical damage produces both oxidative and inflammatory reactions in two important retinal cells; photoreceptors and retinal pigment epithelium cells. It has been proposed that this damage is one many causal factors linked to the development of Cataracts and Age Related Macular Degeneration, AMD.[6]

How does photochemical damage harm the eye?

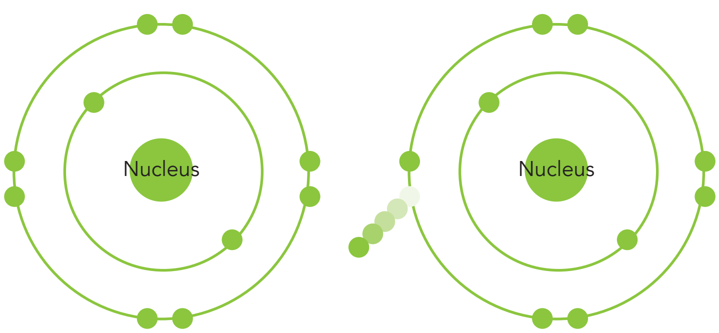
The mechanism for photochemical damage is photo-oxidative stress that results in the production of free radicals that proliferate out of control damaging molecules in our DNA and cells causing cell dysfunction and ultimately cell death.

Recipe for Oxidative Stress

The retina is highly oxygenated and is bombarded with high energy photons daily. This combination of oxygen and high energy light is the perfect recipe for oxidative stress and free radical formation.

Free radicals are formed when healthy molecules become unstable due to the loss of an electron from their outer shell. Electrons that circle the nucleus of an atom must be paired. Unpaired electrons in the outer shell of the molecule atom causes the molecule to become unstable. Electrons are lost or knocked out of their orbit when the molecule is under oxidative stress.

Without an anti-oxidant to donate an electron and stabilize the molecule, a chain reaction occurs that damages DNA, cells and leads to the damage of surrounding cells.



The problem with photochemical damage.

According to Dr. Good, O.D., Ph.D., "Because retinal damage is photochemical in nature, the damaging effects can be cumulative in nature, which may compound across one's lifetime."[7] In other words the damage starts young and builds over a lifetime and is irreversible. We are living longer and preserving our sight. We accumulate damage which leads to even more damage with each subsequent high energy light exposure. This subsequent damage will occur in a fraction of the time that it took the initial damage to occur. Why? Because photodamage results in a debris called lipofuscin that has a potent photosensitizer as one of its components, called A2E. Photosensitizers that we ingest (something as simple as an aspirin or Motrin) or that are inherent in the debris from photodamage developing over time, ramps up the damage to our skin and eyes and cause subsequent photodamage to be worse and happen faster.[4]

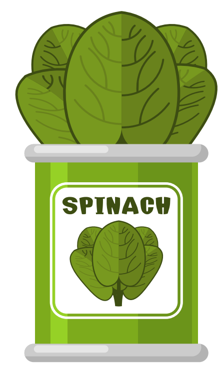
As an example: Your dermatologist will advise you to avoid sun exposure when you use topical Retin A cream because it is photosensitizing and will cause your skin to incur damage at a higher rate and degree. A sunburn is an example of photochemical damage to the skin. Photosensitizing is just as the name implies - it makes us more sensitive to light.

How do we reduce or avoid this photochemical damage?

There are two things we can do:

1. Avoid exposure to high energy light. Wear lenses that filter harmful light.

2. Eat green leafy vegetables like spinach. Even better, eat kale and Swiss chard which are very high in lutein, an important antioxidant in our retina. High levels of antioxidants can contribute the lost electrons required to turn unstable free radical molecules back to healthy molecules in our retina. Our body produces antioxidants from the colorful fruits and vegetables that we eat, especially green ones.

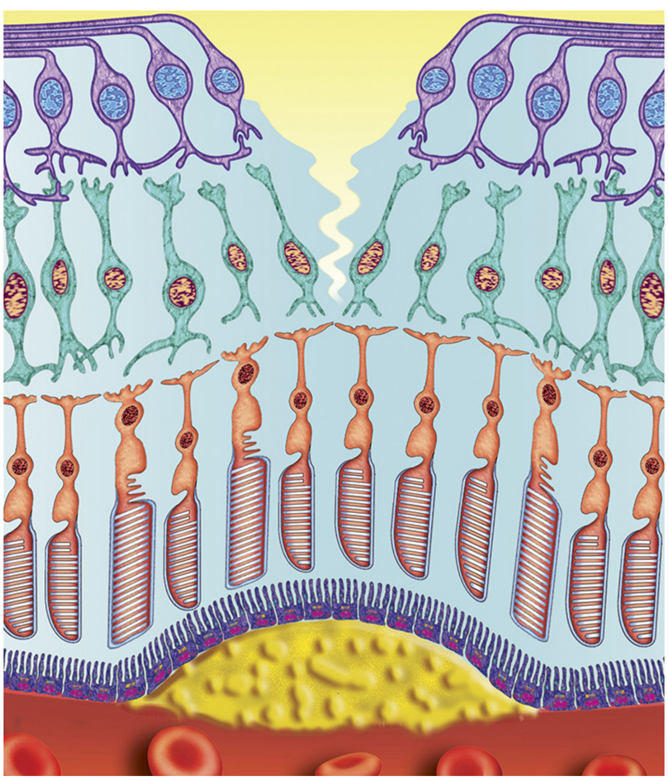


How does photochemical damage potentially lead to AMD?

There are two essential retinal cells that are prone to photochemical damage from excess high energy light exposure; the photoreceptors and the retinal pigment epithelium (RPE). When our photoreceptor cells in our retina absorb excess high energy light, as part of the normal visual cycle, byproducts form. These byproducts are meant to be ingested by Retinal Pigment Epithelium (RPE) cells, then digested by the RPE lysosomes (act like the stomach of the RPE), and finally removed from the retina. This removal of the used up outer segment of the photoreceptor allows the cell to renew itself from its inner segment which pushes up so that a new outer segment is ready to absorb light and begin the visual cycle again in that cell.

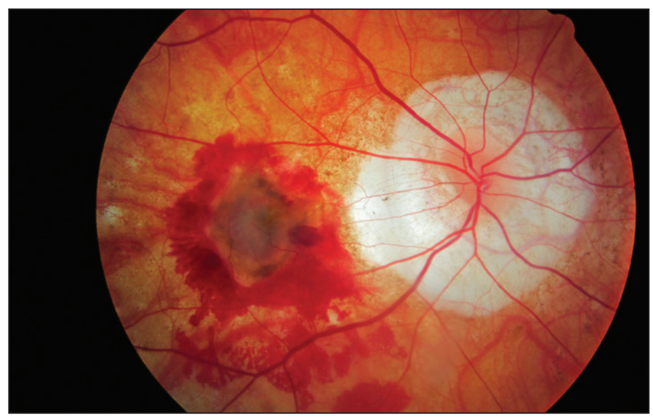
High energy light photochemical injury to the photoreceptor outer segment is the initial site of damage which produces toxic waste products. The ingestion of these waste products place the RPE cell in jeopardy. The RPE's job is to ingest the byproducts of the visual cycle by snipping off the used up photoreceptor outer segment disc. This is called disc shedding. Unfortunately when these photoreceptor outer disc absorb excess high energy light their shed disc contain cytotoxic waste which the RPE is unable to digest. This retinal indigestion, so to speak, results in the buildup of debris that interferes with normal cell function and prevents the RPEs normal transfer of nutrients and waste to and from the photoreceptor cells. The photoreceptor cells depend upon healthy RPE cells to nourish them and to remove waste, without which they become dysfunctional and die.

When the lysosomes of the RPE cell cannot completely break down (metabolize or digest) these toxic substances swell and leak. This will cause the buildup of debris in the RPE.



AMD Drusen Buildup

When this debris begins to form large pockets of drusen in the sub retinal space, the normal transfer of nutrients and waste is prevented. The result is age related macular degeneration. In dry age related macular degeneration (which accounts for 90% of AMD cases) the drusen separates the RPE from the blood supply causing the death of RPE and photoreceptor cells due to the lack of nutrient and waste transfer. In wet advanced AMD angiogenesis (formation of blood vessels) occurs due to oxidative stress and inflammatory reactions that damage the Bruch's membrane (the blood/retinal barrier) allowing unwanted and leaky blood vessels to form and grow into the sub-retinal space. These blood vessels leak toxic fluids and blood obstructing vision and causing permanent retinal scarring. This unwanted retinal angiogenesis causes permanent vision loss in the damaged part of the central retina.



Wet AMD

Which wavelengths are most damaging to the retina?

There is no simple answer to this question. It depends upon the type of retinal cell. It depends upon age, dose, wavelength and intensity.

Generally speaking, the shorter the wavelength the higher the energy and the lower the radiant dose needed to reach the threshold for damage. Damage to ocular cells of our eye, including retinal cells, is dose and wavelength dependent. Photochemical damage only occurs in cells that absorb specific wavelengths of light. In order for cell damage from high energy light to occur the cell must contain chromophores that absorb high energy wavelengths.

In a series of animal studies, even retinal damage was wavelength dependent. The photoreceptor cells were most sensitive to damage from invisible UV and the shortest visible blue from 400nm to 440nm while the RPE cells were most sensitive to damage from 440nm up to 467appx.[2]

"It has been shown that in primates the energy needed to induce threshold photodamage is about 20 times higher for 533 nm monochromatic light than for 440 nm light[5], and about 400 times higher for 500 nm light than for 380 nm light."[6]

– *(Rozanowska, et al.)*[2]

Age related changes to our ocular tissues alter the absorption of harmful wavelengths of light. For example, in an adult eye the anterior ocular tissue cells, the cornea and the crystalline lens, have chromophores that strongly absorb ultra violet radiation. As the adult lens yellows with age it develops chromophores to absorb blue wavelengths. A child's cornea and crystalline lens transmits more harmful light to the retina (UV and blue).

Refocus on ultraviolet radiation. With all of the talk of bad blue light we have lost focus on these most damaging wavelengths.

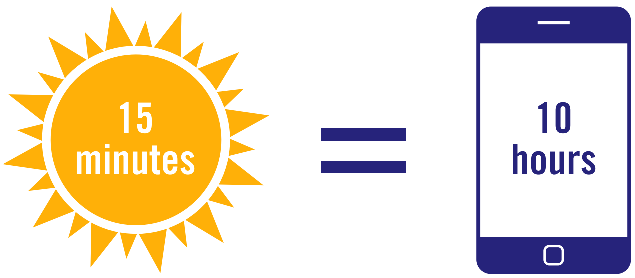
Important note: Standard polycarbonate claims of 100% UV protection block up to 380nm, meeting the definition of UV as defined in the USA by ANSI guidelines. NASA, WHO, Photo-biologist and Photo-chemist typically define UV radiation as ending at 400nm. Whether you define 380 to 400nm as UV or blue light these wavelengths have very high energy from which the eye should be protected. Clear Blue Filter lenses do not transmit any of these wavelengths thru the lens.
It is important when choosing which products to offer, that special consideration be given to children. They require high levels of protection since up to 70% more UV light reaches their retina. The retina is nearly an order of magnitude more sensitive to UV damage than visible light and a child's retina rapidly accumulates damage.[3] Protecting their eyes from the shortest wavelengths of blue light and UV radiation will lessen the amount of damage that occurs in their young vulnerable eyes. Photochromic lenses in their outdoor fully activated state can provide as much as 91% reduction in the highest energy wavelengths between 380 and 460nm. They also provide roughly a 40+% reduction indoors making them a good alternative for children.

Even small amounts of UV damages our eyes, according to the World Health Organization.[9]

"Among adults, only small amounts (1% or less) of UV reach the retina because of absorption by the cornea and lens. However, because UV is known to damage tissue, the importance of this small amount as a cause of retinal damage cannot be ignored. It has been suggested that age-related macular degeneration (a loss of central vision) is associated with light exposure. This disease is a common cause of untreatable blindness in the developed world."[9]

Do high levels of blue light emit from digital screens?

Only low levels of violet and blue light emit from digital device screens, roughly 50 to 160lux. Compare this to 30,000 lux of blue light emitted from midday summer sunlight. To put it in perspective you have to stare at your smartphone for ten (10) hours to get the same dose of blue light as you would from a mere fifteen (15) minutes of midday sun exposure. There is no comparing the intensity levels of high energy light from indoor and outdoor sources. Stare at the sun for less than two minutes and you can develop solar retinopathy and go blind, yet we stare at are phone or tablet screen for hours. Help your customers reduce exposure to both.



Is Blue light from digital screens harmful to the retina and linked to age related macular degeneration?

There is a considerable body of research supporting a plausible link between retinal damage from ambient blue light at intensity levels equivalent to sunlight exposure and age related macular degeneration. However, clinical studies have yet to be conducted to determine if chronic long term exposure to low level emissions from digital device screens poses a significant health risk to our retina. While we await such studies, consider indoor reduction of high energy light a precautionary measure.

Based on their research, on the effects blue, white and green LED light on mouse cone photoreceptor cells, researchers Melisa D. Marquioni-Ramella and Angela M. Suburo state the following: "The question of artificial light sources in AMD etiopathogeny still requires more evidence; however, we cannot presently exclude their potential role as a significant hazard."[1]

Does blue LED lighting and backlit screens expose our eyes to higher percentages of blue light than the sun?

The percentage can be higher but the question becomes…percentage of what?

- Its relative. LED bulbs can have a high percentage of the energy emitted in blue wavelengths however the energy level (intensity) is nowhere near that emitted by sunlight. Therefore you are not getting anywhere near the dose you get from sunlight exposure.

Source	LUX (W/m^2)
Laptop (avg.)	500lux with roughly 32% blue = 160 lux
Sun (midday)	120,000lux with roughly 28% blue = 33,600 lux

Will the amount of protection delivered by blue filtering lenses, that are clear enough for indoor use, provide complete protection from high energy light both UV and blue?

Outdoors the entire eye and surrounding skin tissue must be protected to the fullest from both ultra violet radiation and high energy violet/blue light 400 to 500nm and polarized sunlenses with blue filter in addition to UV protection should always be recommended, but...

Indoors we cannot filter high levels of blue light without wearing a sunglass level tint. Clearly (no pun intended) we cannot wear sunglasses indoors nor when driving at night, if we want to see. Not only is the transmission level in a sunglass too low for good vision indoors it would impact our circadian rhythm. Without enough of the long blue wavelengths between 460 to 480nm reaching our eye, serotonin levels will not remain high enough, making it difficult to stay awake and alert. Individuals who suffer from seasonal affective disorder (SAD) are often prescribed blue light therapy to help their serotonin levels rise.

Many in our industry misunderstand and think that blue filter lenses that are clear enough for indoor use will provide the same protection as a sunglass outdoors.

- Blue filter lenses that are clear enough for indoor use do not eliminate the full range of harmful high energy wavelengths, just narrow selective bandwidths, which vary by manufacturer.
- Since all of the harmful wavelengths cannot be attenuated without a sunglass level tint we must place the emphasis on filtering the most harmful light which is ultra violet radiation and the shortest blue wavelengths from 400 to 440nm.[3] We want our everyday lenses to block ultra violet radiation up to 400nm 100% and filter the shortest most harmful blue wavelengths and we want this in a clear lens. This provides us with added protection when we are outdoors without our sunglasses but is not a substitute for a good pair of, preferably polarized, sunglasses.
- Ask your lens manufacturer for the spectral transmission graphs for their lenses. Make sure that 100% of ultra violet radiation is blocked and that the shortest blue wavelengths are reduced.
- Many allow ultraviolet UVA light to transmit through the lens and there is science based evidence that ultra violet radiation is nearly an order of magnitude more damaging to the retina than visible light.[3] The good news is that Clear Blue Filter Lenses provide complete protection from ultra violet radiation and reduce the shortest, most harmful blue wavelengths.
- Since the photoreceptor cells of our retina are injured by exposure to the shortest blue wavelengths and ultra violet radiation, it's especially important to filter these wavelengths. A vicious cycle of damage leading to more damage that ultimately leads to DNA injury and cell death is initiated when the photoreceptors are exposed to excess amounts of the shortest high energy wavelengths; UV and blue light from 400nm to 440nm.[2]

It is important that any blue light discussion with consumers include the significantly more important need for outdoor protection from sunlight.

Blue filtering lens solutions that are clear enough for indoor use are not a substitution for a good blue filter polarized lens when driving and enjoying outdoor activities. Don't let customers leave misinformed. Assure them that you have products to reduce harmful light transmission in their everyday pair of lenses. Add that when they combine this added protection in their everyday lens with a good polarized blue filter sunglass they will have the best overall protection and that polarized sunglasses will increase their comfort in bright sunlight conditions and when driving by blocking blinding glare. After all the sun is the greatest known source of high energy light damage and every customer should leave with this knowledge.

1 Melisa D. Marquioni-Ramella and Angela M. Suburo, *Photo-damage, photo-protection and age-related macular degeneration, Photochem. Photobiol. Sci.,2015, 14, 1560

2 Malgorzata Rozanowska, Bartosz Rozanowski, Michael Boulton. March (2009). *Light-Induced Damage to the Retina*. Retrieved from: http://photobiology.info/Rozanowska.html

3 Gurrey RK, Ham WT, Mueller HA. Light toxicity in the posterior segment. Duane TD eds. Clinical Ophthalmology. 1985;1–17. Harper & Row Philadelphia

4 Roberts, Joan E. July (2010). *Circadian Rhythm and Human Health*. Retrieved from: http://photobiology.info/Roberts-CR.html

5 Life Science Journal, 2012;9(1) http://www.lifesciencesite.com

6 Youssef PN, Sheibani N, Albert DM. Retinal light toxicity. Eye. 2011;25(1):1-14. doi:10.1038/eye.2010.149.

7 Good, O.D., Ph.D., Gregory W. December (2014). *Light and Eye Damage*. Retrieved from: http://www.aoa.org/Documents/CRG/Blue%20Light%20and%20Eye%20Damage.pdf

8 Gibbs, Philip. May (1997). *Why is the sky blue?* Retrieved from: http://math.ucr.edu/home/baez/physics/General/BlueSky/blue_sky.html

9 *Protection Against Exposure to Ultraviolet Radiation*. Retrieved from: http://www.who.int/uv/publications/proUVrad.pdf

Blue Filter Lens Technologies Quiz

1 credit hour ABO - Technical, Level III
Expiration Date: December 30, 2018

Credit Statement: This course is approved for one (1) hour of CE credit by the American Board Opticianry (ABO).

Directions: Select one answer for each question in the exam and circle the appropriate answer. A minimum score of 80% is required to pass. Quiz is 20 questions and is on two pages. Please print clearly.

Mail to: VISION EASE, Attn: Marketing Fulfillment, 6975 Saukview Drive, Suite 104, St. Cloud, MN 56303

Fax to: 800.289.5456

First Name ______________________ Last Name ______________________

Store Number __________ Address ______________________________

City ______________________ State ____________ Zip __________

1. What wavelengths of blue light stimulate our circadian clock to produce serotonin to wake us?

a. 400nm to 500nm
b. 460nm to 480nm
c. 500nm to 800nm
d. 290nm to 490nm

2. Which wavelength has the highest energy?

a. 290nm
b. 700nm
c. 500nm
d. 370nm

3. The pigments in our photoreceptors are the first to absorb light, initiating our visual cycle. What wavelengths of high energy light are most harmful to these light sensitive cells?

a. Ultraviolet radiation and visible light from 400nm to 440nm
b. 415nm to 455nm
c. 420nm to 440nm
d. 440nm to 470nm

4. Clear Blue Filter lenses provide 100% protection from ultraviolet radiation up to what nanometer?

a. 500
b. 600
c. 700
d. 400

5. We do NOT want to block these blue wavelengths indoors, in our everyday lenses, because we need them to wake up, be alert and feel happy.

a. 500nm to 600nm
b. 460nm to 480nm
c. 400nm to 460nm
d. 300nm to 400nm

6. Short wavelengths of blue light scatter how many times more than red light?

a. 5x
b. 7x
c. 10x
d. 2x

7. Blue haze or blue blur results from the ______________ wavelengths scattering in the oxygen and nitrogen molecules in air.

a. Shortest blue
b. Longest green
c. Longest red
d. Shortest green

8. The reason that ultra violet radiation and short wavelength blue light are potentially harmful to the retina is that excess amounts of these high energy wavelengths cause ____________ damage that results in the formation of free radicals that harm DNA and ultimately cause cell death.

a. Photochemical
b. Photomechanical
c. Photothermal
d. Photostatic

9. Photochemical damage to the eye from ultraviolet radiation and short wavelength blue light is implicated as one of the causal factors in the development of________ and________ .

a. Glaucoma and Dry Eye Syndrome

b. Blepharitis and Conjunctivitis

c. AMD and Cataracts

d. Uveitis and Keratitis

10. There are three blue filter lens technologies. The only one of these that is clear, with no reflection or tint, is called?

a. In-resin

b. Amplified reflection coating

c. Complimentary color absorption tint

d. Deflector coating

11. Of the three blue filter lens technologies, which one employs the principle of constructive interference to double the normal reflection of violet and/or blue wavelengths from the surface of a lens?

a. Complimentary color absorption

b. In-resin

c. Amplified reflection coating

d. Pigmented lenses

12. Of the three blue filter lens technologies, which has UV and short wavelength blue filters built in to the lens and is not a coating or a tint?

a. Amplified reflection coatings

b. Complimentary color tints

c. In-resin

d. Deflector coating

13. Of three blue filter lens technologies, which utilizes complimentary colored tints that have the complimentary or opposite colors to violet and blue?

a. Amplified reflection coatings

b. Complimentary color tints

c. In-resin

d. Deflector coating

14. What are the complimentary colors to violet and blue on the color wheel?

a. Yellow and orange

b. Orange and red

c. Yellow and green

d. Green and orange

15. More than______ultraviolet radiation reaches a child's retina because their crystalline lens has not yet developed the acquired protection of an adult lens.

a. 70%

b. 50%

c. 40%

d. 10%

16. ________________ that reaches the retina is an order of magnitude more damaging than visible light.

a. Long wavelengths

b. Medium wavelengths

c. High wavelengths

d. Ultraviolet radiation

17. We are all born with a set amount of photoreceptors cells and it is important that we protect the eye from high energy light especially since the damage that destroys these cells is both cumulative and _________ .

a. Acute

b. Curable

c. Irreversible

d. Astute

18. Photochemical damage in the retina results in the build up of debris that contains potent______________ which increases the amount of damage and the speed at which damage occurs when the retina is exposed to high energy light.

a. Photoalloy

b. Photosensitzer

c. Photominimizer

d. Photoplate

19. What is the greatest source of high energy light; both UV and short wavelength blue?

a. Smartphone

b. Computer screens

c. Tablets

d. Sunlight

20. What would you advise your customers to do to avoid the sleep deprivation from exposure to light from electronic devices to their eyes too close to bedtime?

a. Walk away from the device 1 to 3 hours before bedtime or change display/brightness settings on the device to lower these light emissions at night

b. Have a special pair of glasses made just for the night use of electronic digital devices

c. Wear sunglasses at night when using electronic digital devices

d. Wear red tint glasses at night when using electronic digital devices

Examination Answer Sheet

1 hour of CE credit by the American Board of Opticianry - Valid for credit through date December 30, 2018

Blue Filter Lens Technologies

Directions: Select one answer for each question in the exam and completely darken the appropriate circle. A minimum score of 80% is required to obtain a certificate. Retain a copy for your records. Please print clearly.

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1.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**11.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
2.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**12.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
3.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**13.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
4.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**14.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
5.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**15.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
6.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**16.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
7.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**17.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
8.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**18.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
9.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**19.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ
10.	Ⓐ	Ⓑ	Ⓒ	Ⓓ	**20.**	Ⓐ	Ⓑ	Ⓒ	Ⓓ

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By submitting this answer sheet, I certify that I have read the lesson in its entirety and completed the self-assessment exam personally based on the material presented. I have not obtained the answers to this exam by any fraudulent or improper means.

Signature: ______________________________ Date: ____________